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Status and Distribution of the Gapped Ringed Crayfish, *Orconectes neglectus chaenodactylus*, in Arkansas

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Abstract

Orconectes neglectus chaenodactylus, the gapped ringed crayfish, is an uncommon and poorly-known, stream-dwelling crayfish that is endemic to the central White River basin of Arkansas and Missouri. This study surveyed a semi-random selection of stream sites in the Arkansas portion of this range in order to characterize the crayfish communities and evaluate the status of *O. n. chaenodactylus* in Arkansas. Collections of a total of 1,107 individual crayfish specimens were made at 45 sites, including 497 *O. n. chaenodactylus* from 21 sites. *Orconectes punctimanus* was the crayfish species most commonly associated with *O. n. chaenodactylus*, occurring at 71% of sites occupied by *O. n. chaenodactylus*. *Orconectes n. chaenodactylus* was found in streams not significantly different from the median characteristics of streams sampled in the study. It is our opinion that *O. n. chaenodactylus* is uncommon in Arkansas, and of only moderate concern due to its limited distribution in the state.

Introduction

The ringed crayfish, *Orconectes neglectus*, was originally described from Mill Creek in Wabaunsee County, Kansas (Faxon 1885). It is a medium-sized, stream-dwelling crayfish, typically growing to a total size of 30.5 – 96.5 mm (Pflieger 1996). It has broad, heavy chelae, a rostrum with a trough-like central depression, and male gonopods with two elongate, slightly curved processes (Pflieger 1996).

The gapped ringed crayfish, *Orconectes neglectus chaenodactylus*, was recognized as a distinct subspecies based on specimens from White Creek in Douglas County, Missouri (Williams 1952). It differs from the nominate subspecies in having chelae with more slender fingers with a broad gap between the fingers and a smaller, shorter rostrum (Williams 1952). In addition to its long-standing recognition based on morphological characteristics, more recent genetic studies suggest the possibility that it is a distinct species (Crandall and Fitzpatrick 1996, Crandall 1998, Dillman et al. 2007).

This crayfish is a tertiary burrower occupying cavities excavated under rocks seated in gravel and coming out at night to forage (Pflieger 1996). Price and Payne (1979) found females with eggs from mid-April to mid-June in North Sylamore Creek, Stone County, Arkansas. They found the mean size at maturity to be 13.5 mm CL, based on the minimum size at which they observed a 50% probability of males being form-I, and observed that 50% reach this size during their first summer. Further, they noted adults molting 4 times in a year, in contrast to the standard expectation of 2 molts per year. Most adults live 2 to 3 years, with older individuals being rare. Price and Payne (1984a,b) observed young-of-the-year to appear in May in North Sylamore Creek and noted no gender differences in growth.

O. n. chaenodactylus has a limited and poorly understood distribution. Original work suggested its endemism to the North Fork White River basin in Missouri (Williams 1954). It was first collected by 1967 in Arkansas (Robison 2002, Smithsonian lot USNM131642). Populations were originally thought to be restricted to the North Fork White River, and intergrades were hypothesized between it and *O. n. neglectus* throughout the remainder of the White River basin (Hobbs 1989, Pflieger 1996, Williams 1952). It has subsequently been reported from a few divergent locations in Arkansas, primarily in the North Fork White River and Sylamore Creek basins. It has recently been discovered, due to a suspected introduction, in the Spring River basin (Rabalais and Magoulick 2006). Taylor et al. (2007) considered it to be "vulnerable" and The Nature Conservancy ranks it as G5T3S2, meaning it is globally secure as a species, found locally in a restricted range as a subspecies, and very rare within the state.

The objective of this study was to document the

diversity and distribution of the crayfish fauna of the North Fork White and Middle White river basins in Arkansas and establish baseline distribution and status of *O. n. chaenodactylus*.

Methods

Study Area and Site Selection

This study focused on the portions of the North Fork White and Middle White river basins in northern Arkansas. Based on the National Hydrology Dataset (NHD), these hydrologic units comprise 5,045 identified stream segments totaling 97,872 km. The Arkansas portion of these units includes parts of Baxter, Cleburne, Fulton, Independence, Izard, Searcy, Sharp, and Stone counties. Since these areas are largely in private ownership, road access to sampling sites was particularly important. U. S. Census Bureau data on roads in these counties was combined with the NHD data using ArcMap™ GIS software to identify stream segments intersected by roads. A random subset of these segments was selected for sampling by generating a random number between 0 and 19 as a start point, and then every 20th segment listed in the pooled list of accessible stream segments was chosen. Since the NHD segments were generally listed clustered by proximity to one another, this reduced the selection of clustered sampling sites and provided a fairly uniform distribution of sites. This process was repeated for each basin and resulted in selection of 72 stream segments as potential sample sites. The selection is considered to be semi-random because of its dependence on road crossings.

Because headwater streams are more numerous and more easily bridged than larger streams, it was acknowledged that site selection was biased toward headwater streams. Some of these headwater streams were intermittent and did not hold water or crayfish when visited for sampling, or were inaccessible due to fencing, posting, and/or lack of landowner permission. When this was the case, the site was omitted or replaced with a nearby site on a larger stream that was not randomly selected for sampling. Some selected segments turned out to be erroneously assigned to the study basins, and were treated in the same manner.

Sampling Methods

The majority of collections were made between September and November 2006. Comparable data for one collection in October 2005 was also included. All available habitats at selected sites were sampled using primarily dip nets or 1-m minnow seines when stream size or flow made dip nets ineffective. This was supplemented by approximately 30 person-minutes of visual search and hand capture of crayfish by overturning larger rocks at sites where such rocks were present and water clarity allowed observation of crayfish presence when such rocks were lifted. At larger river sites, hand capture was completed using snorkeling. As tertiary burrowing crayfish rarely burrow, excavation of burrows was not necessary.

At each sample site, latitude and longitude coordinates in decimal degrees (North American Datum 1927) were recorded for the sample location.

Crayfish were sorted by perceived species, gender determined, and measured to the nearest mm carapace length (CL). A series of voucher specimens including males and females of each species was also taken. All voucher specimens were preserved in 70% ethanol, identification to species verified by the second author, and deposited in the collection of the Illinois Natural History Survey or the AGFC Nongame Aquatics Program reference collection.

Results

Seventy two steam segments were targeted for sampling within the North Fork White River (31 sites) and Middle White River basins (41 sites). Due to lack of water or access, several sites were deleted or relocated, resulting in samples actually being conducted at 45 sites (North Fork White 22 sites, Middle White River - 23 sites). Sites sampled are mapped for each subspecies of *O. neglectus* collected in Figure 1. Crayfish species and numbers collected by site are noted in Table 1.

Nine crayfish species (and 2 subspecies), comprising a total of 1,107 specimens, were collected in this study. The most abundant taxon was *O. neglectus chaenodactylus*, followed by the other species encounted (summarized in Table 2). There were also 14 *O. neglectus* from one site that have not been assigned to subspecies and 4 female *Orconectes* from 2 sites that could not be identified to species. The most commonly encountered taxon in the study was *O. punctimanus*, found at 34 sites, followed by *O. n. chaenodactylus*, *O. ozarkae*, and other species each found at fewer than 10 sites (Table 2). Mean lengths and gender frequencies by species are displayed in Table 3. Length frequencies of *O. neglectus* collected (carapace length in mm) are provided by subspecies in Figure 2.

Table 1: Site locations and crayfish species and numbers collected by site. Collections are grouped by basin. Latitude and longitude coordinates are in decimal degrees, North American Datum 1927.

Middle White Basin

Collection #	Stream	Collection Date	Longitude	Latitude	*C. hubbsi*	*F. fodiens*	*O. longidigitus*	*O. m. meeki*	*O. n. chaenodactylus*	*O. n. neglectus*	*O. n. unknown*	*O. ozarkae*	*O. punctimanus*	*O. virilis*	*P. acutus*
bkw2005-055	White River	10/03/05	-91.6369	35.7566	6		3		17			1			
bkw2006-074	White River	09/11/06	-92.1919	36.10831					41			25			
bkw2006-075	White River	05/11/06	-92.3568	36.21327						36		72		2	
bkw2006-139	Calico Creek	11/02/06	-92.1419	36.11916					13	10	14	6	11		
bkw2006-140	Cataract Creek	11/02/06	-92.2122	36.10568					36	40			5		
bkw2006-141	Sneeds Creek	11/02/06	-92.2525	36.13958					19				4		
bkw2006-142	East Twin Creek	11/13/06	-92.0355	35.97025					4				10		
bkw2006-143	Little Hurricane	11/13/06	-91.9558	36.07538									2		
bkw2006-144	Bailey Creek	11/13/06	-92.0557	36.11806									7		
bkw2006-145	Mill Creek	11/13/06	-91.9059	36.05569					33	5			6		
bkw2006-146	Mill Prong	11/14/06	-92.0822	35.84017					24			11			
bkw2006-147	Sylamore Creek	11/14/06	-92.2688	35.85564					9			1			
bkw2006-148	Roasting Ear Creek	11/14/06	-92.2825	35.94907					32			2			
bkw2006-150	trib to Salado Cr.	11/27/06	-91.7429	35.6187											
bkw2006-151	Wolf Bayou	11/27/06	-91.8387	35.73491				20					2		
bkw2006-152	Pfeiffer	11/27/06	-91.593	35.81525								16	3		1
bkw2006-153	Spring Creek	11/28/06	-91.7211	35.80795					36				4		
bkw2006-154	West Lafferty Creek	11/28/06	-91.8269	35.91333					9				2		
bkw2006-155	Sullivan Creek	11/28/06	-91.6169	35.98318						7		2	3		
bkw2006-156	Poke Bayou	11/28/06	-91.6819	35.90501						12		11			5
bkw2006-157	Chinn Springs run	11/28/06	-91.6393	35.8397						26			3		
bkw2006-158	Mud Creek	11/29/06	-91.4288	35.68015											13
bkw2006-159	Trib to Big Creek	11/29/06	-91.4905	35.74918									1		

Table 1: *continued…*

Norfork Basin

Collection #	Stream	Date	Longitude	Latitude	*C. hubbsi*	*F. fodiens*	*O. longidigitus*	*O. m. meeki*	*O. n. chaenodactylus*	*O. n. neglectus*	*O. n.* unknown	*O. ozarkae*	*O. punctimanus*	*O. virilis*	*P. acutus*
bkw2006-117	Pigeon Creek	10/30/06	-92.3725	36.4163					63				4		
bkw2006-118	Trib to Little Pigeon Cr.	10/30/06	-92.434	36.39256					19				6		
bkw2006-119	Bennetts Bayou	10/31/06	-92.1914	36.46287					35				1		
bkw2006-120	Trib to Bennetts Bayou	10/31/06	-92.1669	36.4592									5		
bkw2006-121	Bennetts River	10/31/06	-92.1492	36.42849					20				11		
bkw2006-122	Little Creek	10/31/06	-92.1286	36.48005					19						
bkw2006-123	Poor Hollow Br.	10/31/06	-92.1113	36.46866					2				7		
bkw2006-124	Little Creek	10/31/06	-92.0239	36.44228					24				20		
bkw2006-125	Trib to Bennetts R.	10/31/06	-92.0066	36.48894									8		
bkw2006-126	Trib to Big Creek	10/31/06	-91.9669	36.38181											
bkw2006-127	Trib to Big Creek	10/31/06	-92.0337	36.36044								1	14		
bkw2006-128	Shipman Creek	10/31/06	-92.0156	36.38655	1								6		
bkw2006-129	Panther Creek	11/01/06	-92.3438	36.3555									8		
bkw2006-130	Trib to Fall Creek	11/01/06	-92.3463	36.3325									19		
bkw2006-131	Camp Spr. Hollow Cr.	11/01/06	-92.323	36.37671					13				15		
bkw2006-132	Big Creek	11/01/06	-92.1146	36.35611					31				26		
bkw2006-133	Norfork Lake	11/01/06	-92.1554	36.32473									7		
bkw2006-134	Trib to S. Brushy Cr.	11/01/06	-92.0545	36.32172		5							1		
bkw2006-135	Brushy Creek	11/01/06	-92.0741	36.29765									10		
bkw2006-136	Trib to S. Brushy Cr.	11/01/06	-92.0708	36.27787									4		
bkw2006-137	Big Creek	11/02/06	-92.4276	36.31									12		
bkw2006-138	Trib to Norfork L.	11/02/06	-92.281	36.27458									7		

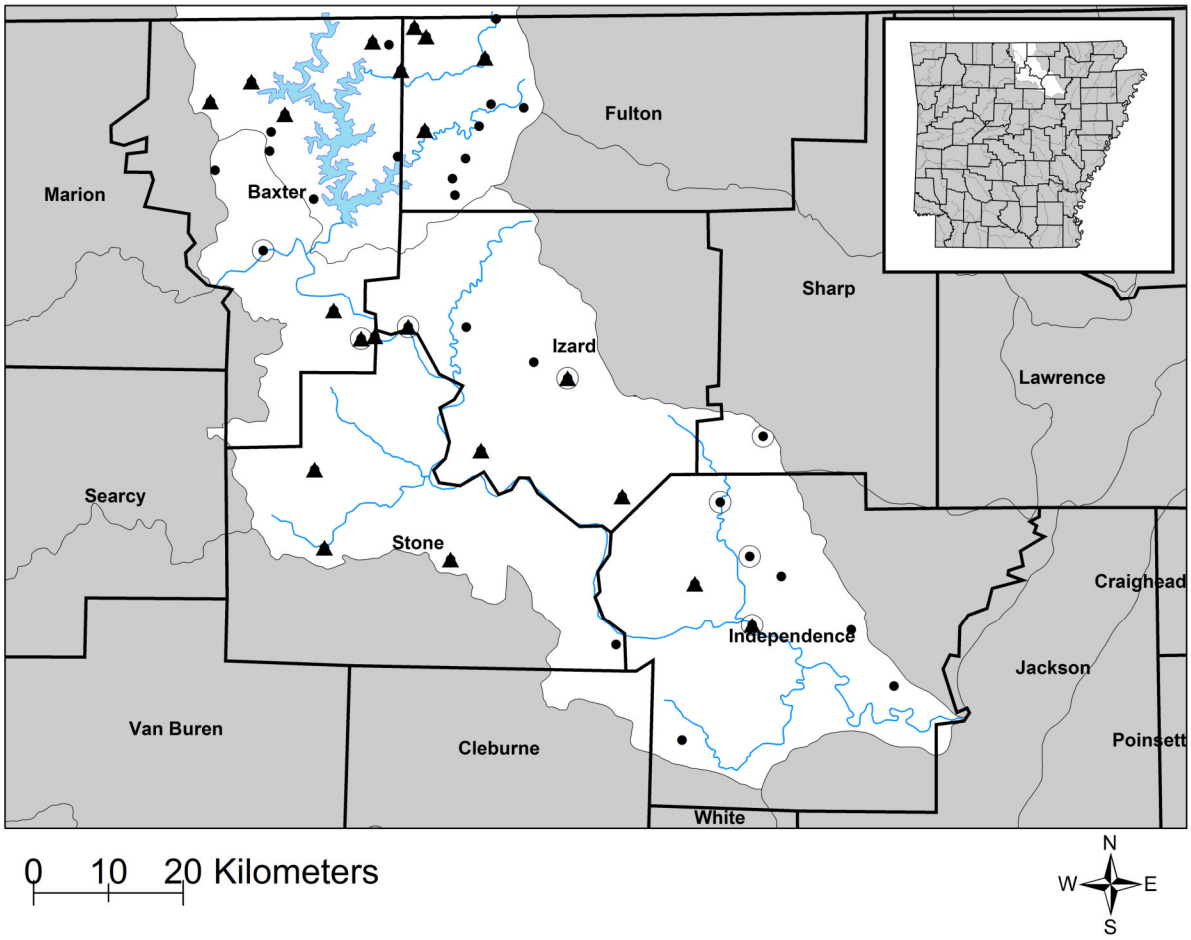


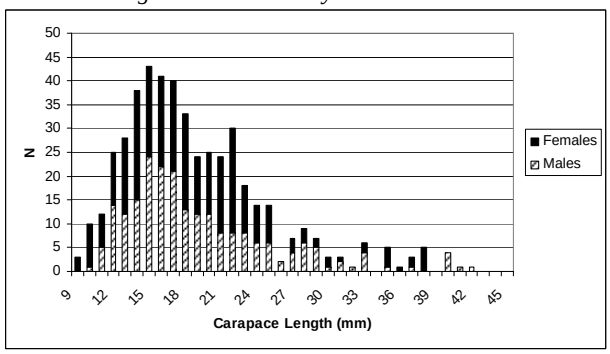
Figure 1: Map of north-central Arkansas depicting watershed areas included in this study. Black triangles indicate sites where *Orconectes neglectus chaenodactylus* was encountered. Small circles indicate sites where *O. n. chaenodactylus* was not encountered. Larger rings indicate sites where *O. n. neglectus* was encountered.

Table 2: Numbers of crayfish collected in study by species, % of total, number of sites occupied, and % of sites occupied.

Species	N	%	# of sites	% of sites
C. hubbsi	7	1	2	4
F. fodiens	5	<1	1	2
O. longidigitus	3	<1	1	2
O. meeki meeki	20	2	1	2
O. n. chaenodactylus	497	45	21	47
O. n. neglectus	136	12	7	16
O. n. ssp.	14	1	1	2
O. ozarkae	148	13	11	24
O. punctimanus	254	23	34	76
O. virilis	2	<1	1	2
P. acutus	19	2	3	7

Species associations and dominance are reported in Table 4. *O. n. chaenodactylus*, a Species of Greatest Conservation Need (Anderson 2006), co-occurred repeatedly with three species, *O. punctimanus* (71%), *O. ozarkae* (24%), and *O. n. neglectus* (14%). It also co-occurred at a single site with *C. hubbsi* and *O. longidigitus*. Species associations with *O. n. chaenodactylus* were also examined using the metrics of dominance, constancy, and fidelity (Table 4), as described by Pflieger (1978). *O. n. chaenodactylus* was the dominant species where found, comprising an average of 65% of the crayfish collected at those sites. Constancy results indicated that *O. punctimanus* was the associated species found most often at sites having *O. n. chaenodactylus* (75%). Since *O. punctimanus*

Orconectes neglectus chaenodactylus



Orconectes neglectus neglectus

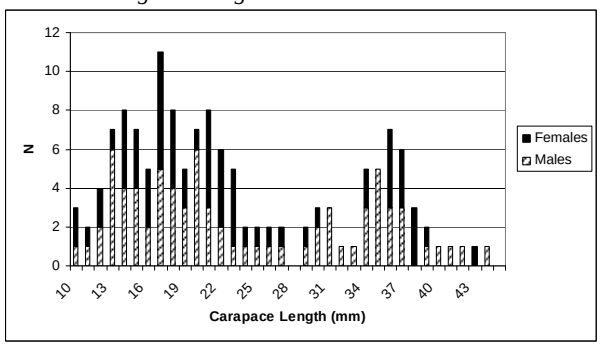


Figure 2: *Orconectes neglectus chaenodactylus* and *Orconectes neglectus neglectus* length frequencies.

Table 3: Crayfish mean carapace length (CL) in mm, standard deviation (sd), and gender breakdown by species.

Species (N)	Mean CL	sd CL	Males	Females
C. hubbsi (7)	-	-	1 (14%)	6 (86%)
F. fodiens (5)	20.6	1.8	2 (40%)	3 (60%)
O. longidigitus (3)	-	-	2 (52%)	1 (48%)
O. meeki meeki (20)	19.8	5.6	9 (45%)	11 (55%)
O. n. chaenodactylus (497)	19.0	6.3	231 (46%)	266 (54%)
O. n. neglectus (137)	23.4	9.2	75 (55%)	62 (45%)
O. neglectus not assigned to ssp (14)	20.5	2.8	8 (57%)	6 (43%)
O. ozarkae (147)	23.8	6.0	82 (56%)	65 (44%)
O. punctimanus (254)	20.7	5.1	123 (48%)	131 (52%)
O. virilis (47)	50.0	4.2	1 (50%)	1 (50%)
P. acutus (19)	15.6	5.4	4 (21%)	15 (79%)

was found at 76% of all sites, almost identical to its frequency of occurrence with *O. n. chaenodactylus*, this does not imply any selection by these species for similar site characteristics. Fidelity estimates, incorporating all sampled sites regardless of *O. n. chaenodactylus'* presence, were greatest for *O. n. neglectus* (50%), an artifact of the underrepresentation of the true range of *O. n. neglectus* among the sites included in analysis.

Table 4: *Orconectes neglectus chaenodactylus* (*O.n.c.*) species associations, including dominance, constancy, and fidelity, after Pflieger (1978). Dominance = the percentage of all crayfish collected at sites with *O. n. chaenodactylus* that are the given species. Constancy = the percentage of *O. n. chaenodactylus* sites also having the given species. Fidelity = the percentage of sites having the given species that also have *O. n. chaenodactylus*.

	O. n. chaenodactylus	*O. n. neglectus*	*O. ozarkae*	*O. punctimanus*
Dominance (%) at *O.n.c.* sites	65	10	3	19
Constancy (%) at *O.n.c.* sites	-	20	25	75
Fidelity (%) at *O.n.c.* sites	-	50	5	33

Discussion

Distribution

O. neglectus was described by Faxon (1885) from what turns out to be a small, disjunct population in Mill Creek, Wabaunsee County, Kansas. Williams (1952) recognized *O. n. chaenodactylus* as a distinct subspecies in the North Fork White River basin in Missouri. The subspecies was later recognized from the Arkansas portion of this basin and nearby basins in the Middle White River area. Collections held at the Smithsonian include four lots from Arkansas identified as *O. n. chaenodactylus*. Three of these lots fall within the Sylamore Creek area (USNM131644, USNM131642, and USNM220143). The fourth lot (USNM177056) is from War Eagle Creek in Madison County, far outside the suspected range of *O. n. chaenodactylus*. This record is considered suspect and should be reexamined, as in extensive sampling in that area by Wagner et al. (2010) collected *O. n. neglectus*

as the most common species but no *O. n. chaenodactylus* specimens were encountered.

This study greatly expanded the documented distribution of this crayfish by documenting its presence at several sites within its suspected range. It appears to be a common crayfish in tributaries of Lake Norfork, throughout the Sylamore Creek sub-basin, in the White River downstream to Batesville, and in a few other tributaries in the Middle White River basin. It was previously reported that the 2 subspecies of *O. neglectus* intergraded over a wide area, so it surprised us to observe clearly recognizable populations of both subspecies co-occurring at a few sites. These situations are currently being examined in more detail using genetic analyses.

Genetic data implies that *O. n. chaenodactylus* is a distinct species (Crandall and Fitzpatrick 1996, Crandall 1998, Dillman et al. 2007). Recent studies show that the situation is much more complex, with *O. neglectus* possibly containing several cryptic species (Dillman et al. 2007). This shines some doubt on the true distribution of all lineages within *O. neglectus*, but we are reasonably confident that *O. n. chaenodactylus* will be found to be a valid taxon at some level and that its range includes the North Fork White River basin and portions of the Middle White River basin. It is interesting to observe that some sites in this area are occupied by 2 or more likely taxa of *O. neglectus*. The distribution and population levels of *O. n. chaenodactylus* in Missouri are understood primarily by Pflieger's (1996) work, with limited work since (R. J. DiStefano, Missouri Department of Conservation, *pers. comm.*).

Length Frequency

Visual inspection of the length frequency graph for *O. n. neglectus* seems to indicate 2 or possibly 3 age classes, whereas there are less well-defined classes for *O. n. chaenodactylus* (Figure 2). However, the variability in individual growth rates results in overlapping age classes that are not readily evident in these graphs. This could be confounded by the fact that the length measurements are taken over a 3-month time period and combined among several sites which may have different growth rates. Price and Payne (1984a) sampled North Sylamore Creek on a monthly basis and their length frequency analysis suggested 5 overlapping, normally-distributed age classes. Their oldest age class had an upper CL of 35.4 mm, whereas our largest *O. n. chaenodactylus* had a CL of 43 mm. They found only males over 31mm, while we found only males over 39 mm. On closer inspection, we would note that our largest specimens came from collections from the White River, suggesting that growth rates in this large river habitat could be significantly greater than those in smaller streams, such as North Sylamore Creek. As the White River sites sampled were within the reservoir release created trout-waters and North Sylamore Creek is a spring-fed stream, we do not think that the difference in growth rates can be explained by a major difference in water temperature.

Recommendations

O. n. chaenodactylus appears to have a localized distribution in northcentral Arkansas (and into Missouri), but it is abundant at sites where it does occur. It has been introduced into the South Fork Spring River, where it is proving to be invasive and displacing other species. While the subspecies' limited range causes it to be of some conservation concern, its abundance where found reduces its priority for conservation efforts.

Acknowledgments

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